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Animas River Stakeholders Group Mine Drainage Treatability Study

October 1, 2009 (Updated 11/6/09)



Introduction

Water Tectonics conducted an acid mine drainage treatability study for the Animas River Stakeholders Group in Colorado. This treatability study tested the efficacy of Wave Ionics Electrocoagulation (EC) to remove metals from two mine locations; CC06 – Gold King Mine, and CC19 – American Tunnel Mine. Samples were collected 8/20/09 and received by Water Tectonics 8/28/09. The goals of this treatability study were to remove metals to meet Colorado Department of Public Health and Environment Water Quality Standards.

Methods

Two containers were received for each sample (CC06 and CC19). Each container was thoroughly mixed and 2.5 gallons was poured from each container to make a 5 gallon composite for each of the two samples. Influent samples were collected from the composite samples. The samples were then treated. After settling, the supernate was decanted into a clean beaker and filtered using filter paper simulating granular media filtration.

Table 1 Water Tectonics analytical parameter test methods and detection limits.

Parameter	Unit	Test method	Detection Limit
Conductivity	mS/cm	Hach HQ40d meter	NA
pH	Standard units	Hach HQ40d meter	NA
Dissolved Oxygen	mg/L	Hach HQ40d meter	0.1
Turbidity	NTU	Hach 2100P meter	0.01

NA = Not Applicable

Table 2 Third party analytical laboratory parameter test methods and detection limits (mg/L) .

Parameter	Unit	Test method	Detection Limit (PQL)
Aluminum	µg/L	EPA 6010B	110
Cadmium	µg/L	EPA 6010B	11
Cadmium	µg/L	EPA 200.8	0.20
Copper	µg/L	EPA 6010B	11
Copper	µg/L	EPA 200.8	1.0
Iron	µg/L	EPA 6010B	56
Lead	µg/L	EPA 6010B	110
Lead	µg/L	EPA 200.8	2.9
Manganese	µg/L	EPA 6010B	110
Zinc	µg/L	EPA 6010B	56

Results

CC06 – Gold King Mine

The influent had a slightly rusty color with iron colored solids that quickly settled. Following treatment, a large floc formed that quickly separated and sank to the bottom of the container. Turbidity was highly reduced in the EC treated samples. ARSG provided influent samples for total and filtered samples for dissolved metals analysis (Table 4). Fresh influent samples were collected at the time of treatment. Metals concentrations were greatly reduced in the EC treated effluent compared to the raw influent (Table 5, Table 6).

Table 3 Gold King Mine influent and effluent (parameters analyzed by Water Tectonics).

Parameter	Unit	Influent	Treated Effluent
Conductivity	mS/cm	2.74	2.51
pH	Standard units	2.77	7.37
Dissolved Oxygen	mg/L	7.87	10.57
Turbidity	NTU	57.1	0.19

NA = Not Applicable

Table 4 Gold King Mine, influent total and dissolved metal samples provided by ARSG (analyzed by Onsite Environmental).

Parameter	Unit	Total metals	Dissolved metals
Aluminum	µg/L	28000	27000
Cadmium	µg/L	75	77
Copper	µg/L	6400	6500
Iron	µg/L	88000	83000
Lead	µg/L	ND (<110)	ND (<110)
Manganese	µg/L	34000	35000
Zinc	µg/L	24000	25000

Table 5 Gold King Mine, influent and effluent total metals collected by Water Tectonics (analyzed by Onsite Environmental).

Parameter	Unit	Influent	Treated Effluent
Aluminum	µg/L	27000	210
Cadmium	µg/L	73	15
Copper	µg/L	6200	6.9
Iron	µg/L	58000	78
Lead	µg/L	25	ND (<2.9)
Manganese	µg/L	34000	24000
Zinc	µg/L	24000	420

Table 6 Gold King Mine, influent and effluent dissolved metals collected by Water Tectonics (analyzed by Onsite Environmental).

Parameter	Unit	Influent	Treated Effluent
Aluminum	µg/L	27000	170
Cadmium	µg/L	73	14
Copper	µg/L	6200	ND (<11)
Iron	µg/L	22000	ND (<56)
Lead	µg/L	ND (<110)	ND (<110)
Manganese	µg/L	35000	25000
Zinc	µg/L	25000	390

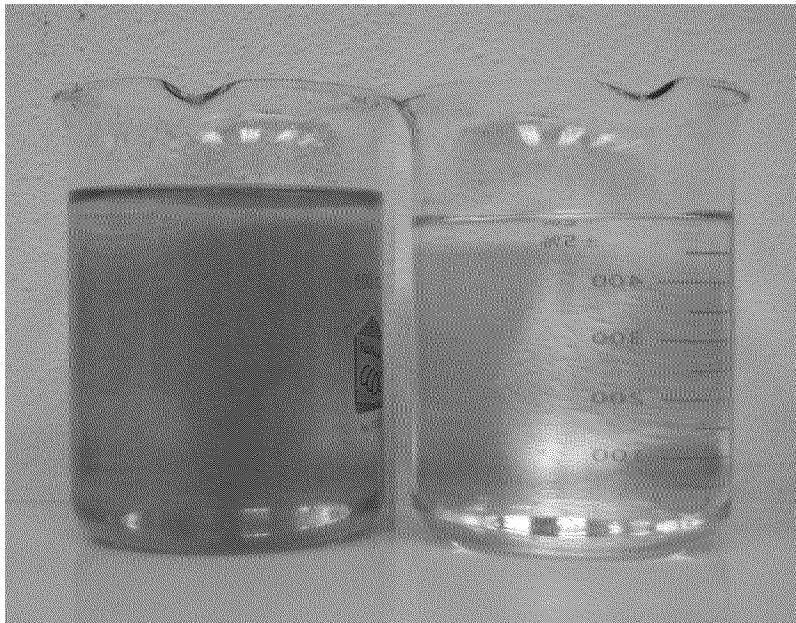


Figure 1 Gold King Mine; Influent (left), Effluent (right).

CC19 – American Tunnel Mine

The influent had a slightly rusty color with iron colored solids that quickly settled. Following treatment, a large floc formed that quickly separated and sank to the bottom of the container. Turbidity was highly reduced in the EC treated samples. ARSG provided influent samples for total and filtered samples for dissolved metals analysis (Table 8). Fresh influent samples were collected at the time of treatment. Metals concentrations were greatly reduced in the EC treated effluent compared to the raw influent (Table 9, Table 10).

Table 7 American Tunnel Mine influent and effluent (parameters analyzed by Water Tectonics).

Parameter	Unit	Influent	Treated Effluent
Conductivity	mS/cm	2.96	3.64
pH	Standard units	2.75	7.64
Dissolved Oxygen	mg/L	7.27	10.85
Turbidity	NTU	142	0.85

Table 8 American Tunnel Mine, influent total and dissolved metal samples provided by ARSG (analyzed by Onsite Environmental).

Parameter	Unit	Total metals	Dissolved metals
Aluminum	µg/L	5400	5100
Cadmium	µg/L	ND	ND (<11)
Copper	µg/L	12	ND (<11)
Iron	µg/L	140000	150000
Lead	µg/L	ND (<110)	ND (<110)
Manganese	µg/L	48000	50000
Zinc	µg/L	18000	18000

Table 9 American Tunnel Mine, influent and effluent total metals collected by Water Tectonics (analyzed by Onsite Environmental).

Parameter	Unit	Influent	Treated Effluent
Aluminum	µg/L	5200	ND (<110)
Cadmium	µg/L	2.3	ND (<0.20)
Copper	µg/L	9.6	5.2
Iron	µg/L	64000	87
Lead	µg/L	3.1	ND (<2.9)
Manganese	µg/L	49000	18000
Zinc	µg/L	18000	ND (<56)

Table 10 American Tunnel Mine, influent and effluent dissolved metals collected by Water Tectonics (analyzed by Onsite Environmental).

Parameter	Unit	Influent	Treated Effluent
Aluminum	µg/L	5000	ND (<110)
Cadmium	µg/L	ND (<11)	ND (<11)
Copper	µg/L	ND (<11)	ND (<11)
Iron	µg/L	35000	ND (<56)
Lead	µg/L	ND (<110)	ND (<110)
Manganese	µg/L	47000	14000
Zinc	µg/L	19000	ND (<56)

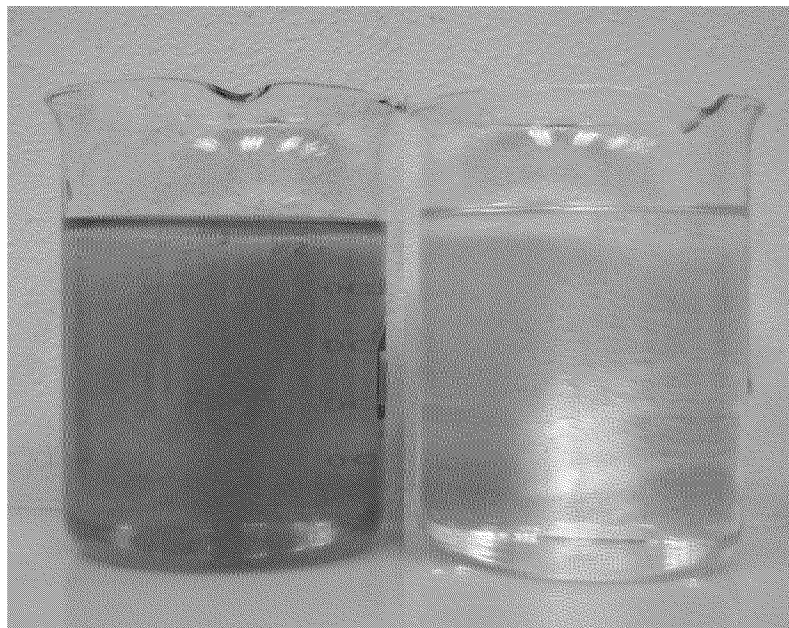


Figure 2 American Tunnel Mine; Influent (left), Effluent (right).

Electrocoagulation was very effective in treating the acid mine runoff. It reduced turbidity and most heavy metal concentrations. Manganese was high in the effluent and will require additional testing and treatment optimization.